Stabilized Approach Criteria

Bridging the Gap Between Theory and Practice

Peter Zaal
San José State University
NASA Ames Research Center

Spring InfoShare 2018

March 21, 2018

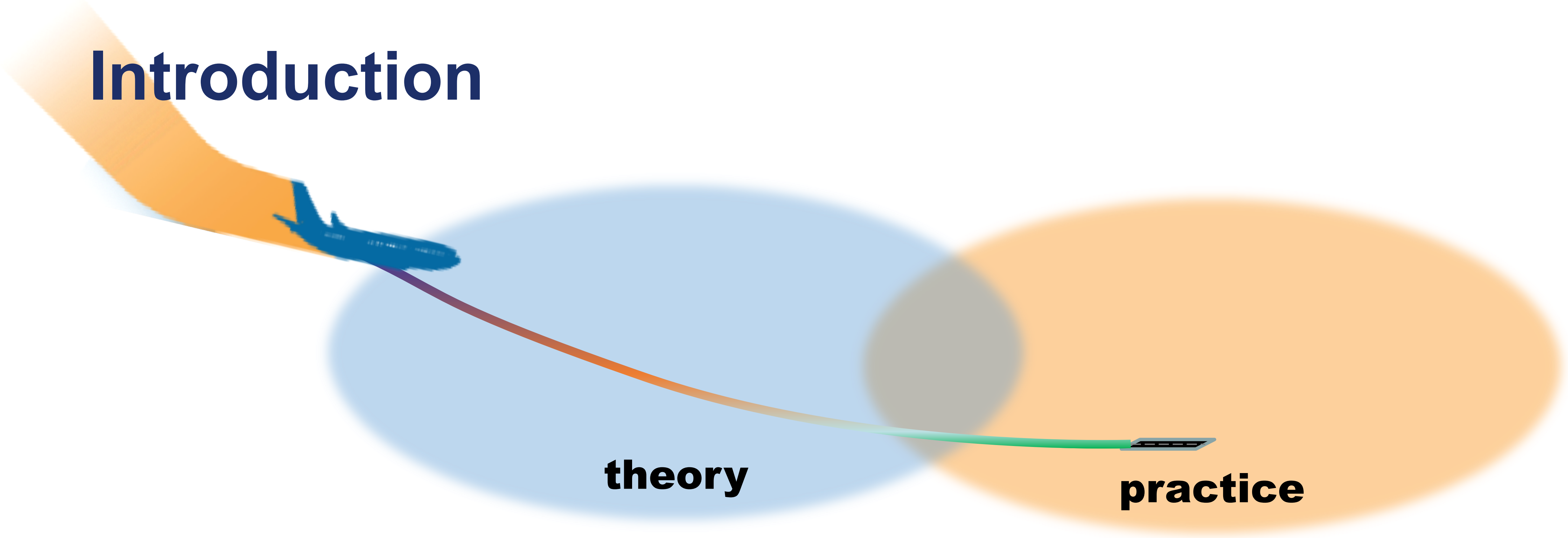
Introduction

- Approach and landing is the most common phase of flight for aviation accidents

- 83% of runway excursions could have been avoided with a decision to go around (Flight Safety Foundation study)

- Half of runway excursions result from a stabilized approach to a contaminated runway (Boeing study)

Introduction



Stabilized approach criteria have been established

However, we have a gap…

Only 3% of unstable approaches result in a go-around (FSF)

Why is there a gap?

Insufficient pilot communication

Lack of go-around maneuver practice

Criteria are too complex or unrealistic

Fatigue

ATC induced pressures

Belief that the approach can be corrected

Management disengagement

Pressure of flight schedule

Late takeover from automation

Lack of situation awareness

Excessive workload

Lack of policies that encourage go-arounds

How can we close the gap?

Alter the criteria

- Simplify
- Change stabilization height
- More realistic thresholds

Encourage compliance

- Management awareness and tracking
- No fault go-around policies
- Use of active callouts

Proposed FSF Guidelines

- On correct flight path
- Correct configuration
- Speed is between V_{ref} and V_{ref} + 10 (without wind adjustment)
- Sink rate less than 1,000 fpm
- Stabilized thrust
- Use active communication – e.g. “Continue/Go-around” callout at 300 ft AGL

Purpose

Examine, through simulation, the issues surrounding the FSF recommendations and where some in industry are moving toward

Experiment Goal

Determine the critical factors in *go-around criteria* and explore the appropriate settings for the thresholds of those factors

Human-In-The-Loop Experiments

Experiment Development › Conduct Experiment › Document Findings

	Experiment Development	Conduct Experiment	Document Findings
Phase I	Workshop with stakeholders *June 2017*	First experiment took place in *Oct/Nov 2017*	
Phase II	Workshop with stakeholders *March 2018*	Second experiment planned for *July 2018*	The final report will be publically available *End 2018*

Experiment Description

- Premise: evaluate touchdown performance under various starting conditions

- Pilots instructed to always land

- Expectation: some starting conditions would not allow pilots to land smoothly or in the touchdown zone

- Touchdown performance and questionnaire data: provide insights into possible universal go-around criteria

Flight Simulators

- **3 CAE Level D Flight Simulators**

Airbus A330-200

Boeing 737-800

Boeing 747-400

- **The three aircraft types tested provided the ability to compare results between *narrow-body* and *wide-body* aircraft**

Experiment Factors

Gate Height	Glideslope Deviation	Localizer Deviation	Rate of Descent	V_{ref} Deviation
100	0	0	1000 / 1250	+0 / +10 / +20
300	0 / 0.5	0 / 0.5	1000 / 1500	+0 / +10 / +20
500	0 / 0.75 / 1.5	0 / 0.75 / 1.5	1000 / 1500	+0 / +10 / +20

Fixed environmental conditions:

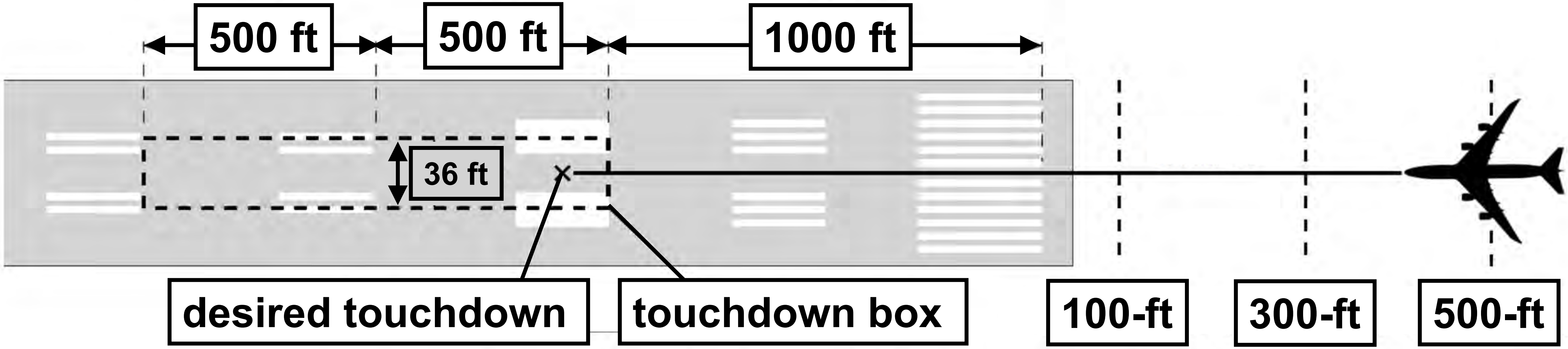
1. San Francisco International Airport
2. CAVU
3. 10-kts tail wind, moderate turbulence
4. Wet runway, medium braking

Fixed aircraft state:

1. Maximum landing weight
2. Landing configuration

Landing Performance Criteria

1. Longitudinal touchdown: 1,000 - 2,000 feet from the threshold
2. Lateral touchdown: centerline between main wing gear
3. Sink rate at touchdown: < 6 fps
4. Bring the aircraft to a full stop as quickly as possible



Questionnaires

Pre-Sim Questionnaire

- Demographics
- Airline's current stable approach criteria
- Opinions on airline's current stable approach criteria

Post-Run Questionnaire

- **Workload**, **fatigue**, and **risk** during run
- Would you have done a go-around and why?

Post-Sim Questionnaire

- Personal stable approach criteria based on simulator experience

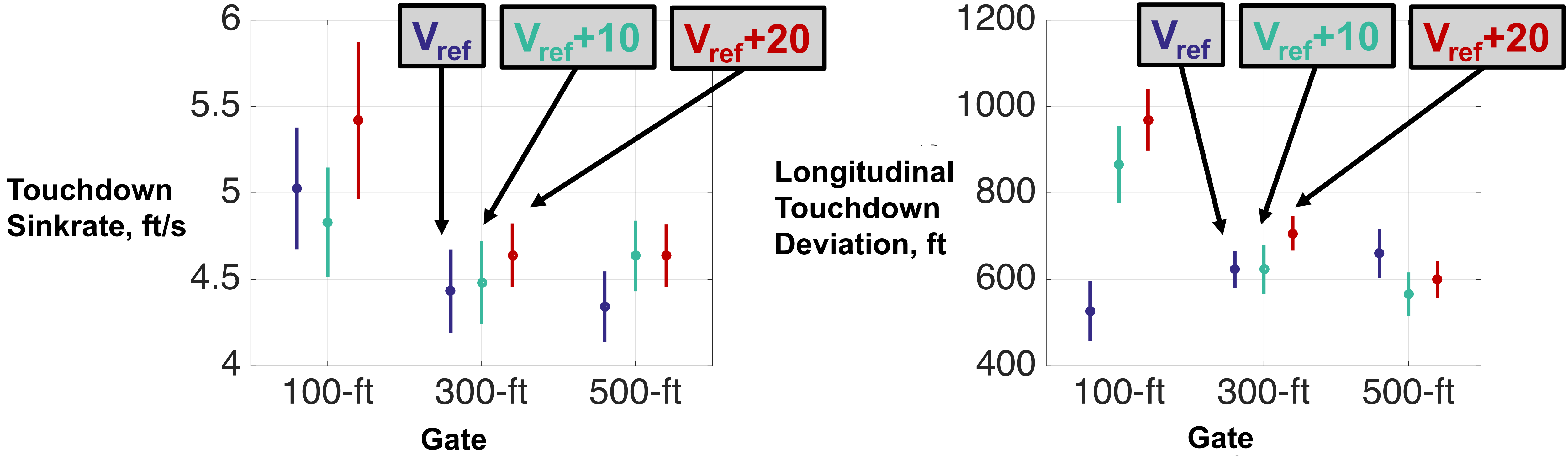
Experiment Considerations

1. Six crews per simulator
2. Captain and First Officer alternated as the pilot flying
3. 184 runs per crew / eight one-hour sessions / two days
4. Both pilots completed a questionnaire after each run

300-feet gate, 0.5 dot LOC dev

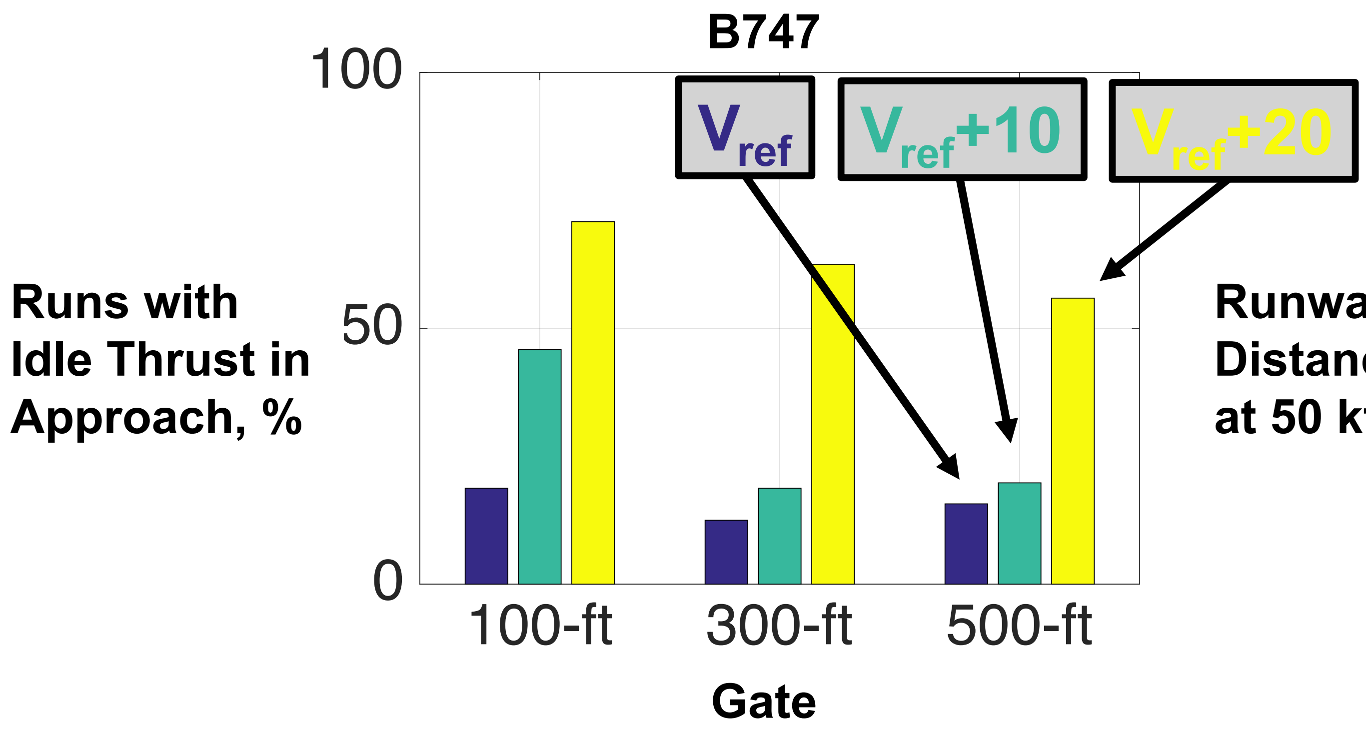
Aggregate Simulator Data Results

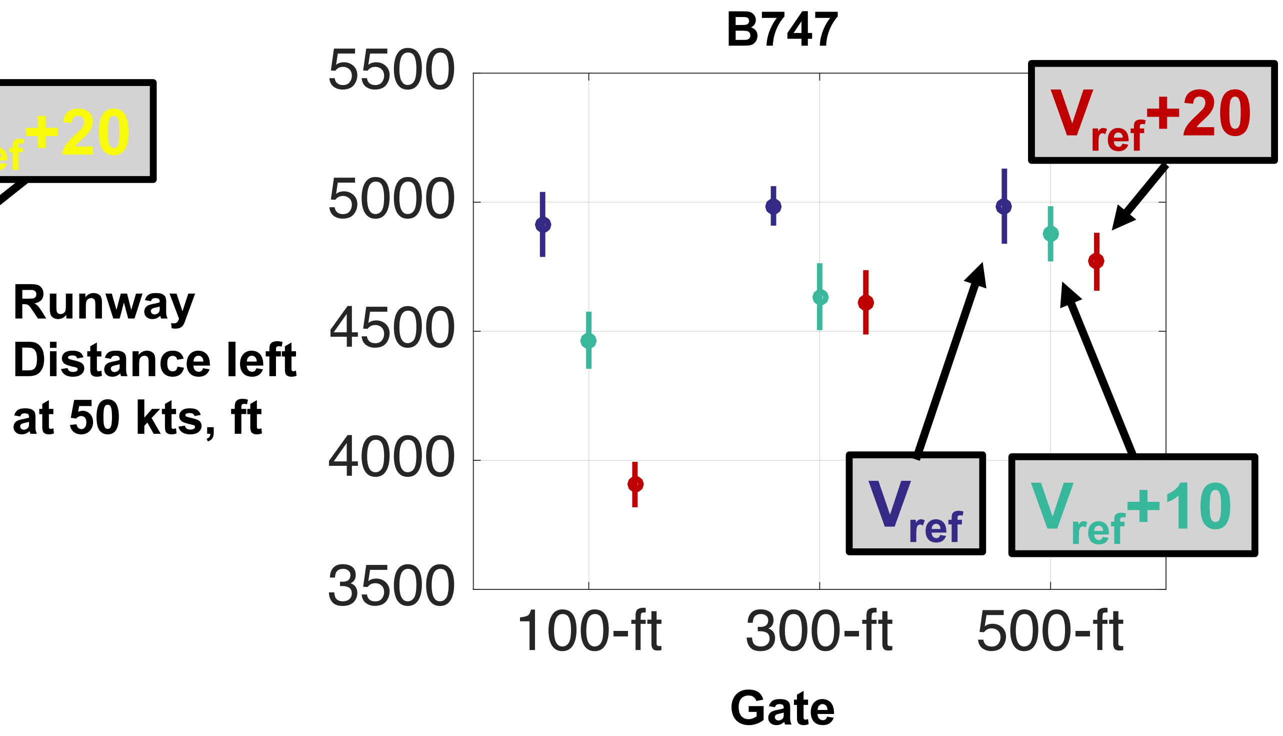
- Aircraft type had the strongest effect
- V_{ref} deviation had a strong effect at 100-ft
- Limited effects of starting conditions at 300-ft and 500-ft



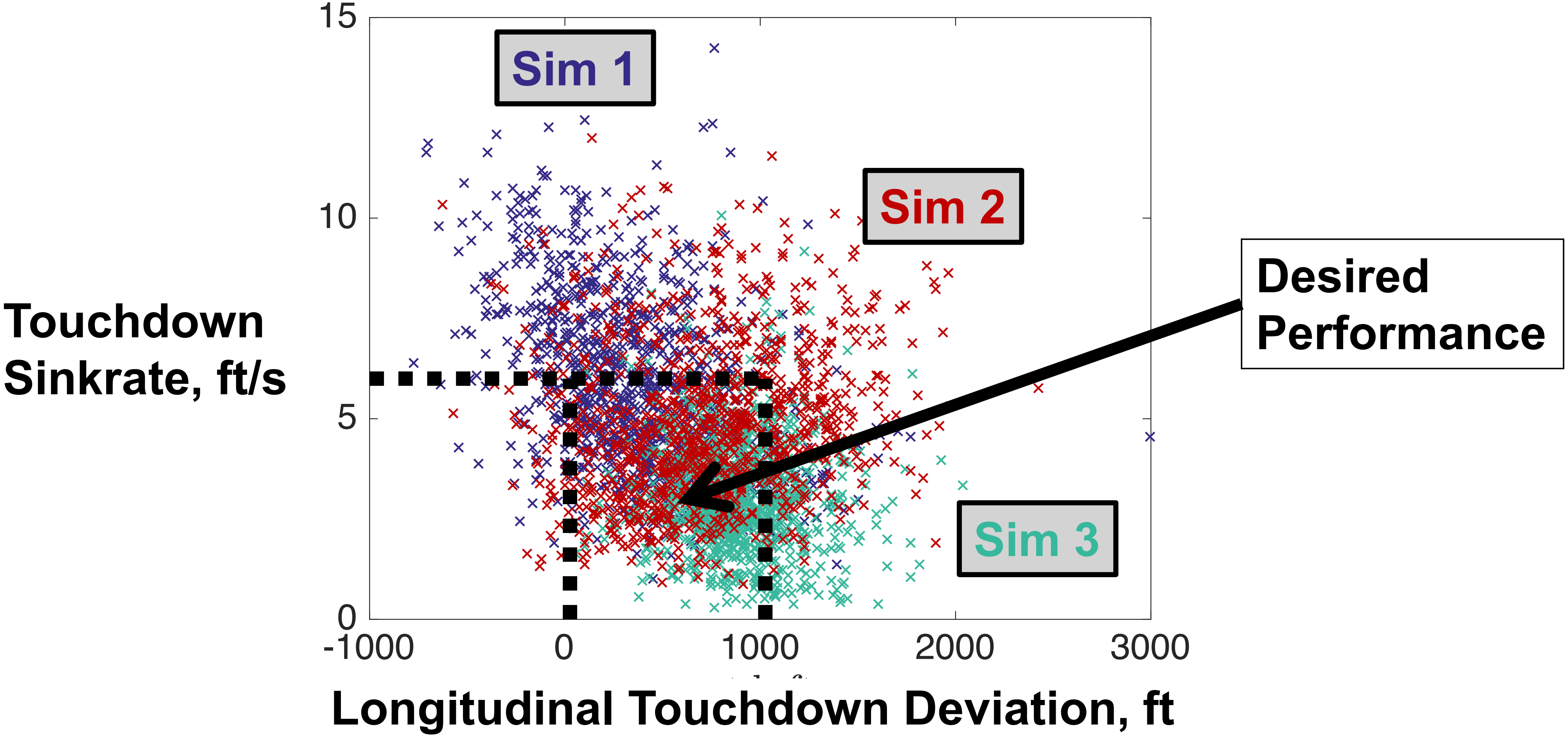
By Simulator Data Results

- Similar effects for all aircraft types
- V_{ref} deviation had a strong effect at 100-ft
- Idle thrust in approach occurred more often at lower gate heights



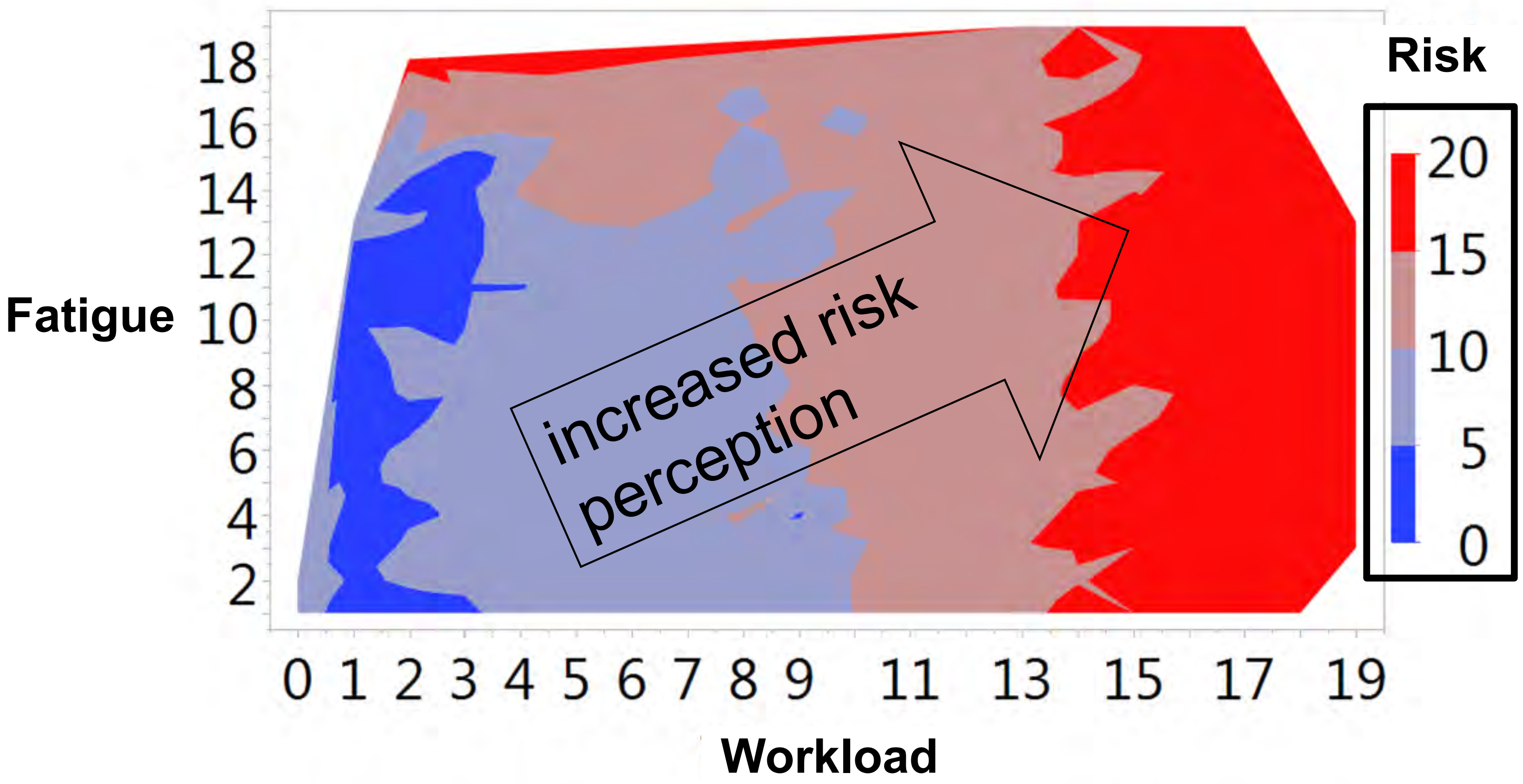


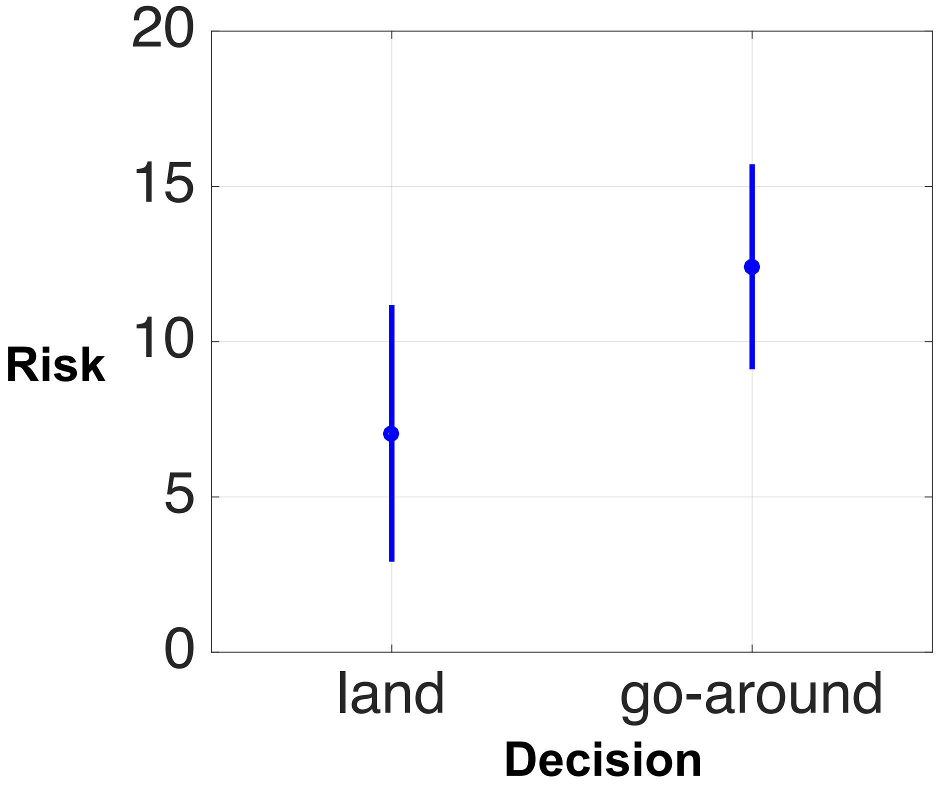
Differences Between Simulators



Questionnaire Risk Analysis

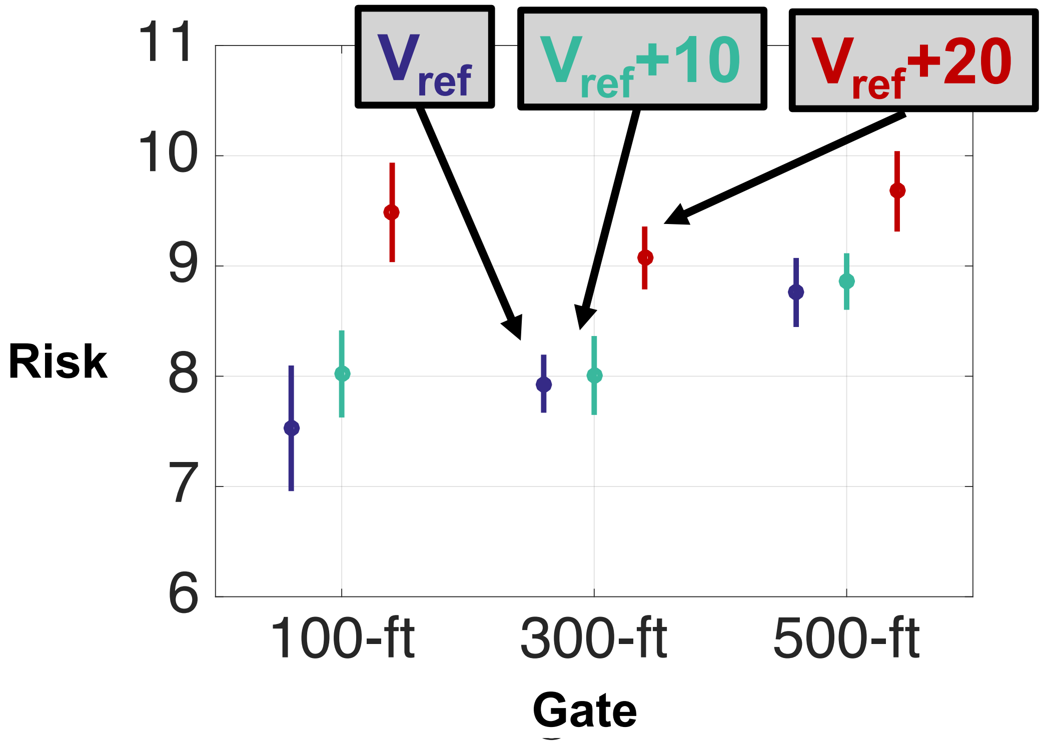
- **Fatigue and workload strongly influence perceived landing risk**
- **Decision to go around made more often with higher perceived risk**

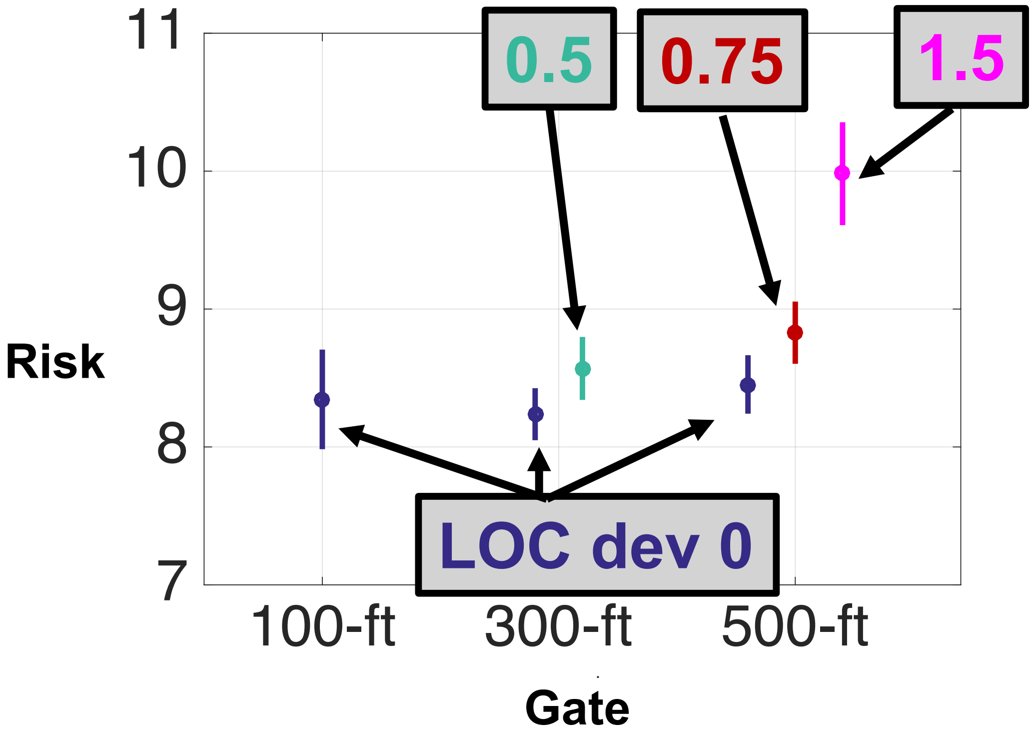




Questionnaire Risk Analysis

- **Risk perception was mainly affected by initial condition (not touchdown performance)**
- **Perceived risk increased with increasing V_{ref} and LOC deviation**

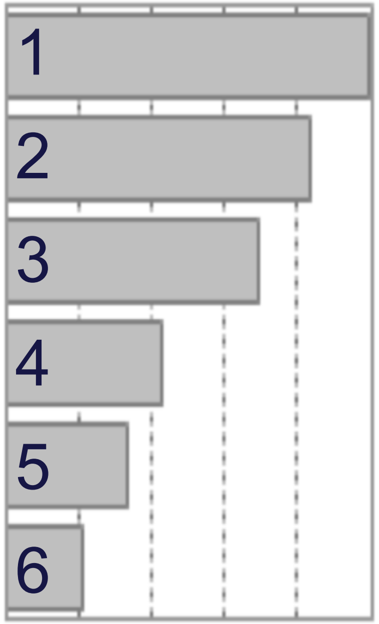




Go-Around Response Modeling

V_{ref} deviation followed by localizer deviation had the strongest influence on go-around decision

Predictor	Contribution	Portion	Rank
Vref Deviation	14.81	0.28	1
Localizer Deviation	12.51	0.24	2
Glideslope Deviation	10.43	0.2	3
Simulator Flown	6.44	0.12	4
Rate of Descent Deviation	5.01	0.1	5
Gate Height	3.17	0.06	6



Conclusions – Closing the Gap

1. Results show little difference between the 300-ft and 500-ft gates

2. Conditions at the 100-ft gate introduced significant differences in touchdown performance

3. V_{ref} deviation and localizer deviation at the starting gate had the strongest influence on perceived risk and go-around decision

Next Steps

1. A second experiment will be conducted July 2018 focusing on effects of environmental and airport conditions

2. A workshop here at InfoShare tomorrow (March 22) at 10:30 AM, will help us to develop and plan the next experiment

3. Results of the two experiments combined will give insights into possible universal go-around criteria

4. The final report will be publically available

Stabilized Approach Criteria

Bridging the Gap Between Theory and Practice

Peter Zaal
San José State University
NASA Ames Research Center

Spring InfoShare 2018

March 21, 2018